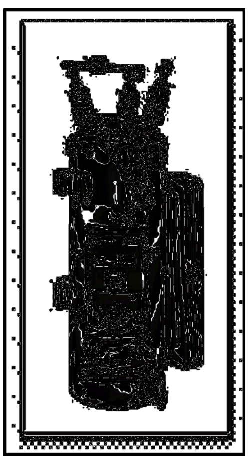
U.S. DEPARTMENT OF ENERGY | Electricity Delivery & Energy Reliability

A "Model-Centric" Approach to Smarter Electric Distribution Systems

Orange and Rockland Utilities (ORU), is an investor-owned utility and a subsidiary of Consolidated Edison Incorporated (Con Edison), and is located in suburban New York, New Jersey, and Pennsylvania, west of New York City. ORU is a key participant in Con Edison's $272 million Smart Grid Investment Grant (SGIG) project to modernize electric distribution systems.

With $136 million in Recovery Act funding from the U.S. Department of Energy, Con Edison and ORU expect to install smart grid technologies that provide: (1) lower frequency and duration of outages, (2) deferral of capital expenditures, (3) operational savings, (4) lower electricity costs, and (5) lower electricity consumption and environmental emissions through voltage and volt-amperes reactive (VAR) management, reduced line losses, and conservation voltage reductions.



Voltage Control Device

The focus of ORU's SGIG pilot project is twofold. First, the pilot involves adding hardware and communications to five circuits and two substations to create a small smart grid system. This affects about ten thousand customers (mostly residential) in New Jersey. Second, the pilot involves operating this equipment to optimize the economic performance of ORU's New York distribution circuits.

According to Jim Tarpey, recently retired Vice President of Operations for ORU, "Without the Recovery Act we would not have gotten the go ahead from the NY Public Service Commission and the NJ Board of Public Utilities to make the smart grid investments. This meant that instead of waiting 6-7 years to get the job done, we are able to complete it in 3 years."

Keeping Costs Low

ORU is focused on keeping its electric distribution modernization costs as low as possible. According to Jim Tarpey, "Our approach to smart grid is to make as much use of existing equipment as possible, minimize customization, establish two-way communications, and bring the electric distribution system under real-time computerized control." Mr. Tarpey says ORU's customers are demanding improvements that reduce the number of power outages and accelerate service restoration after storm-related damages. At the same time, however, Mr. Tarpey says customers are cost-sensitive and, during these stressful economic times, are not supportive of significant rate increases.

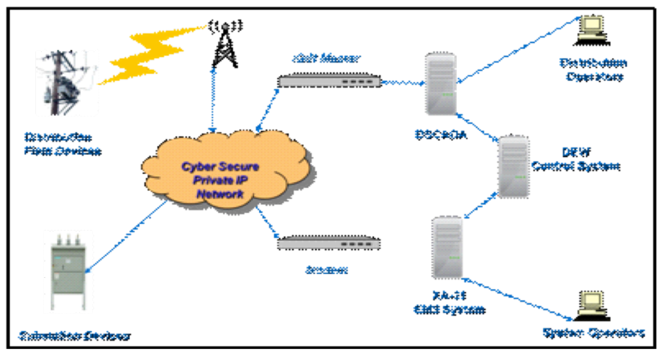
As a result, ORU is working with their State Public Service Commissions to ensure that only the most cost-effective smart grid solutions—ones that provide measurable benefits for citizens and businesses at acceptable costs—get deployed. Mr. Tarpey notes that successful implementation of its SGIG project offers potential economic advantages for the region. "We are eager to provide our customers better service quality and reliability while minimizing cost increases. We think our smart grid improvements can be a differentiator and help attract new businesses and jobs to the region."

Switched Capacitor Banks

ORU needs hard data to make the business case and they are focused on getting that information and packaging it properly and in ways regulators can understand and support. They are expecting to justify the business case on three factors: deferred capital expenditures, loss and conservation voltage reduction savings, and storm restoration savings. They also plan to factor in reduced carbon and other environmental emissions.

A Model-Centric Approach

The cornerstone of ORU's smart grid strategy involves a model-centric approach for operating electric distribution systems more efficiently and controlling the new smart grid devices that are being deployed as part of the SGIG project. The approach involves basing distribution system operations on a powerful system analysis software platform that operates as a real-time "virtual" Supervisory Control and Data Acquisition System (SCADA) for the entire electric delivery system.



ISM-Based Control System

The system acquires SCADA data from across the service territory in real time to improve accuracy, refine the model, and improve situational awareness on a much more granular level. The system also evaluates the status of equipment and key indicators such as switch states, fault currents, and voltage levels, to dynamically dispatch control signals to achieve stated objectives such as automatic feeder reconfiguration for optimum customer restoration, and voltage and VAR optimization.

According to Charlie Scirbona, Manager of Smart Grid Engineering at ORU, "Our model-centric approach allows us to install relatively low-cost, off-the-shelf, automated devices with little need for customization. Furthermore, the approach provides the flexibility needed to incorporate tomorrow's emerging technologies cost-effectively."

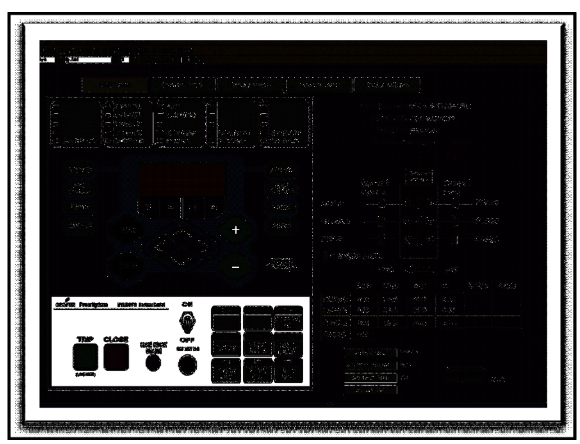
For example, with SGIG funding, ORU is using an Integrated System Model (ISM) and Distribution Engineering Workstation (DEW) software platform to implement automated storm detection, automated storm outage prediction, automated fault isolation, automated reconfiguration for restoration, automated fault location, coordinated volt/VAR control, conservation voltage reduction and real-time power flow analysis (from transmission substations to distribution substations, and over circuits and feeders to every customer meter) as part of the SGIG project.

ISM and DEW operate in two modes: optimum efficiency and maximum capacity and performs two major smart grid functions: (1) Coordinated Control and (2) Automated Restoration.

<u>Coordinated Control</u> involves processing data coming in from many sources including Geographic Information Systems, Weather Services, Outage Management Systems, Energy Management Systems, and SCADA. After evaluating system conditions, ISM and DEW dispatch control signals that automatically manage voltage levels by turning capacitor banks on or off, and automatically adjusting other voltage control devices, such as regulators and transformer load tap changers.

Under <u>optimum efficiency mode</u>, the controls are aimed at reducing line losses, minimizing voltage levels for conservation voltage reductions, and making power factor improvements to lower needs for reactive power. Under <u>maximum capacity mode</u>, which is operated during peak load conditions, the ISM and DEW control signals adjust voltage and VAR levels to enable the system to serve higher levels of demand.

<u>Automated Restoration</u> involves system monitoring and dispatch of ISM and DEW control signals for automatic fault locating, isolation, and system restoration. Over the years, ORU has experienced steady improvements in their System Average Interruption Frequency Index (SAIFI) as a result of adding more field re-closers and automatic loop schemes, setting the stage for the ISM DEW Auto Restoration function. This system, through monitoring and dispatch, fully automates restoration operations. Line reclosers equipped with communications packages that are tied into SCADA clear faults automatically and report status and other system parameters in real time. Using this real time data, the ISM DEW Auto Restoration System determines the location of the fault then opens SCADA-operable switches to isolate the fault to segments of 250 customers or less.



Re-Closer Control Screen

Formerly this was an operation that had to be planned by an operator and performed manually by field crews and would take between 30 and 45 minutes to perform. The ISM DEW Auto Restoration System then closes the appropriate switching devices (also formally a manual operation planned by operators and performed by field crews) rerouting power automatically in seconds in the event of a disturbance or outage on the system. The complexity of having to handle the coordination of a large number of SCADA operable devices for any conceivable set of contingencies is solved in real time by having the central intelligence of the ISM performing a "faster than real-time" system analysis that coordinates and executes the restoration plan.

According to Mr. Scirbona, "We are able to speed up our ability to restore the system after outages occur with these advanced technologies while significantly reducing the number of customers that would have been affected by a long-term outage. During severe storm conditions, we estimate it costs ORU and ratepayers about $175,000 per hour or more to hire and dispatch supplemental repair crews and roll trucks. Allowing quicker restoration and system recovery during such storm conditions can result in substantial savings that help keep costs down for our customers."

Lessons Learned

Full deployment of the ORU pilot project is expected by the summer of 2012. In the pilot project, ORU has learned the value of careful planning before installing equipment to ensure legacy systems are fully utilized and back-office systems are functional and ready when the devices are fully deployed. This approach has allowed ORU to avoid mistakes and save money. In building out communications infrastructure, for example, ORU chose low-frequency and narrow-bandwidth radio channels that required construction of only one additional radio tower and enabled use of a dedicated communications pathway for all control signals and equipment status updates. ORU has been able to harden this dedicated path and ensure appropriate cyber security protections.

Engineering analysis based on the algorithms in the ISM DEW system has been applied to thirteen circuits in New York to optimize circuit performance. Actual data comparing pre-optimization from the 2010 system peak to post optimization 2011 system peak, shows promising results. Circuit optimization strategies included phase balancing and capacitor design and placement analysis. Phase imbalances on certain circuits dropped from about 59 percent to about 15 percent. Power factors on certain substation transformers increased from about 93 percent to about 99 percent. This shows that when real time measured data is coupled with the ISM DEW system algorithms, ORU's circuits can be successfully optimized. This example shows that the model-centric approach is providing valuable analysis that can shorten planning times and testing costs.

Path Forward

ORU explains that its model-centric system, once fully operational, can be expanded for use in the remainder of its service territory with relatively small incremental costs. Mr. Scirbona says, "We are using an open architecture, so we are not limited to specific manufacturers. Once we have shown ourselves and our regulators that there are measurable and cost-effective benefits for our customers, we can proceed with installing and integrating additional distribution automation technologies and devices. Thanks to the SGIG project, we were able to design the system with the capacity to expand our model-centric approach and cover our entire service territory."

Learn More

Case Study--Orange and Rockland

The American Recovery and Reinvestment Act of 2009 provided DOE with $4.5 billion to fund projects that modernize the Nation's electricity infrastructure. For more information visit www.smartgrid.gov or www.oe.energy.gov. There are five recent reports available for download:

- *Smart Grid Investment Grant Progress Report*, July 2012
- *Demand Reductions from the Application of Advanced Metering Infrastructure, Time-Based Rates, and Customer Systems – Initial Results*, December 2012
- *Operations and Maintenance Savings from the Application of Advanced Metering Infrastructure – Initial Results*, December 2012
- *Reliability Improvements from the Application of Distribution Automation Technologies and Systems – Initial Results*, December 2012
- *Application of Automated Controls for Voltage and Reactive Power Management – Initial Results*, December 2012